Dansk Ståldag 2011

Bolting material

Arvid Nilsson

Brief introduction to Arvid Nilsson

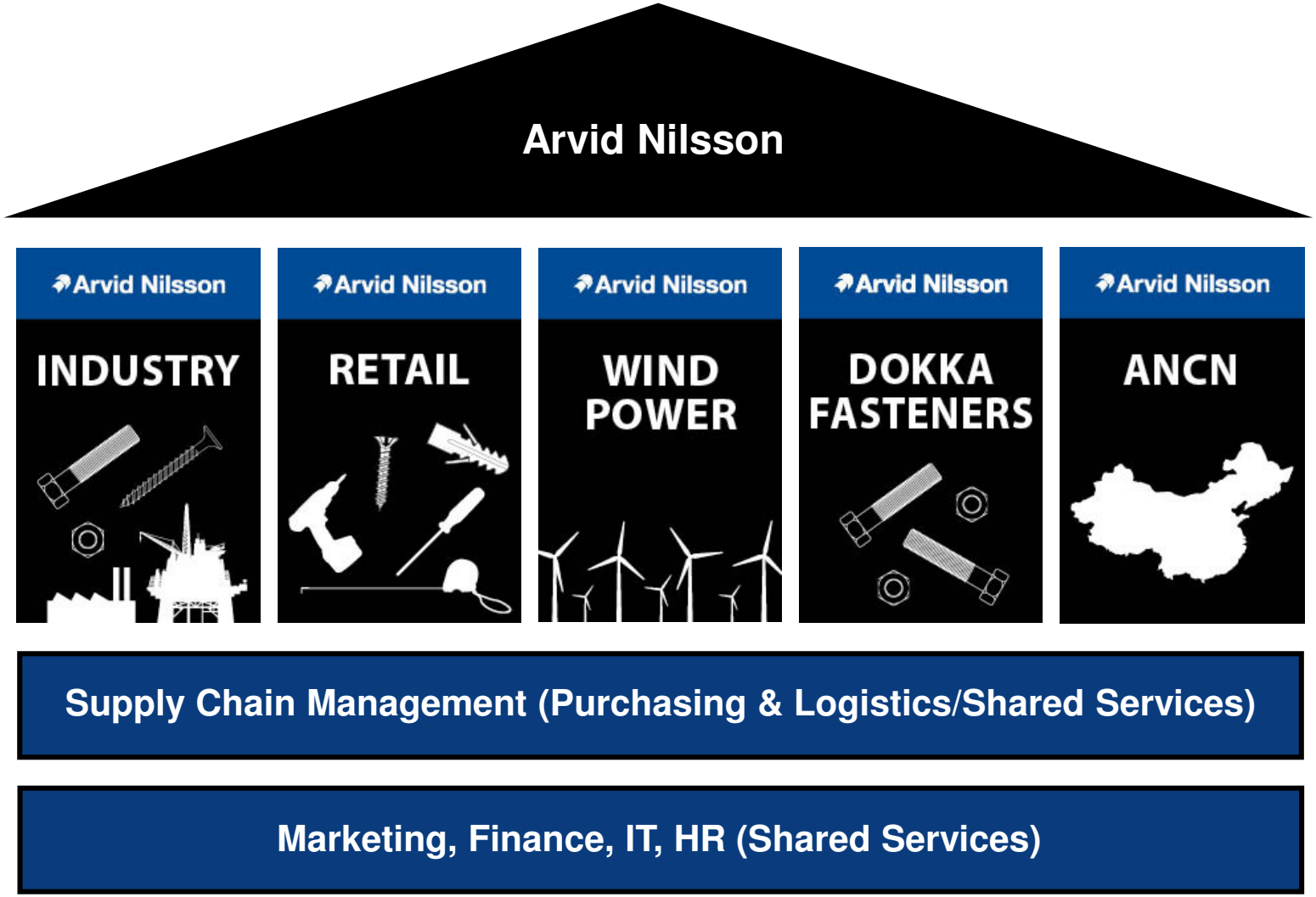
Bolting material in accordance with EN 1090-2

- EN 14399 Structural bolting for pre-loading
- EN 15048 Non-preloaded structural bolting

Installation of bolts

- Torque, clamping force, deviation
- Lubrication and friction control

3 Organisation



Arvid Nilsson geography

Norway | Dokka

Denmark

Head Office

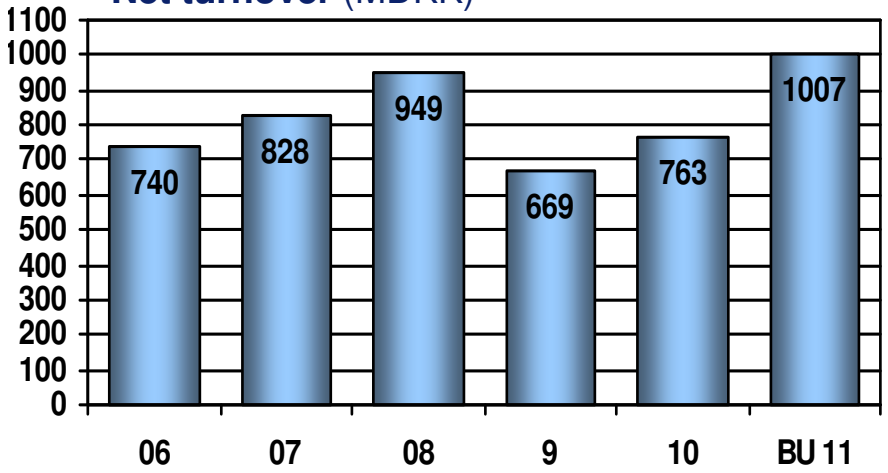
Sweden & Logistics

China - Shanghai

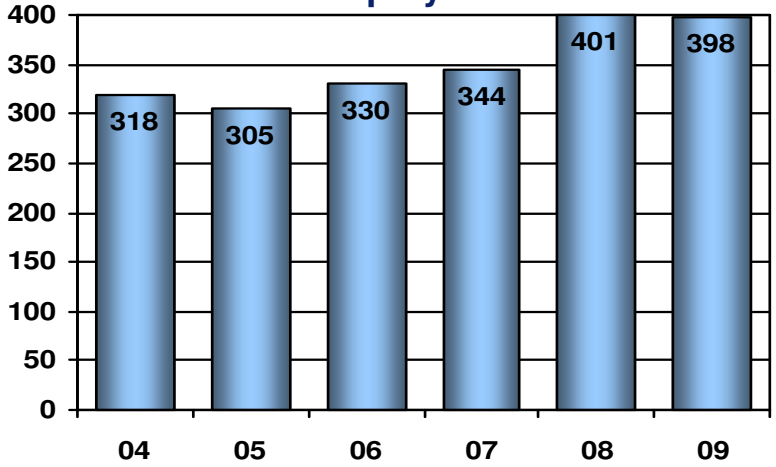
and legal entities (colour)

Key figures

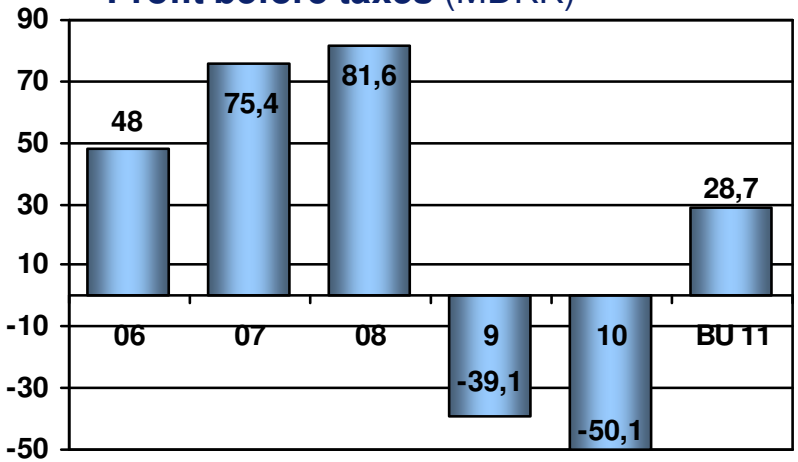
Net turnover (MDKK)



Number of employees



Profit before taxes (MDKK)



Bolting material according to EN 1090

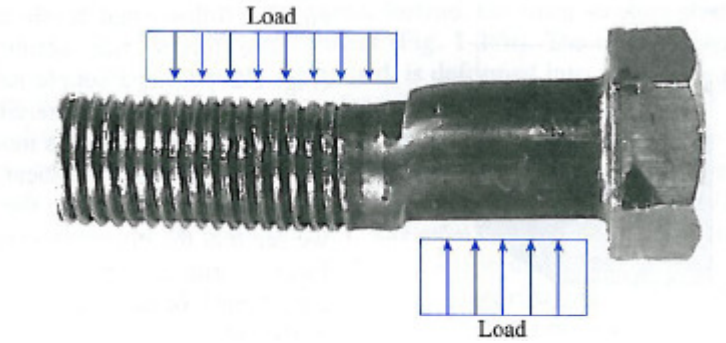
- EN 14399 Structural bolting for pre-loaded assemblies
- EN 15048 Non pre-loaded structural bolting

Loading of screw joints

Preloaded joint

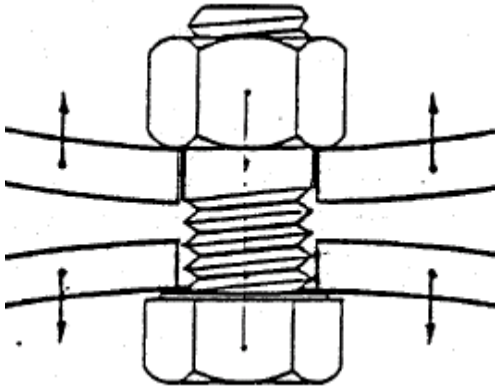
Longitudal stress

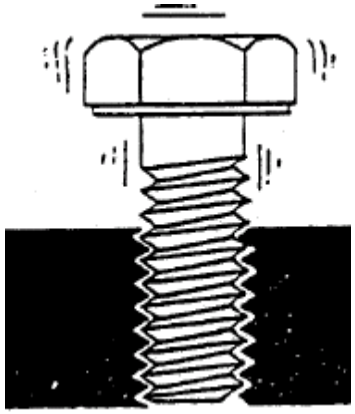
Non preloaded joint

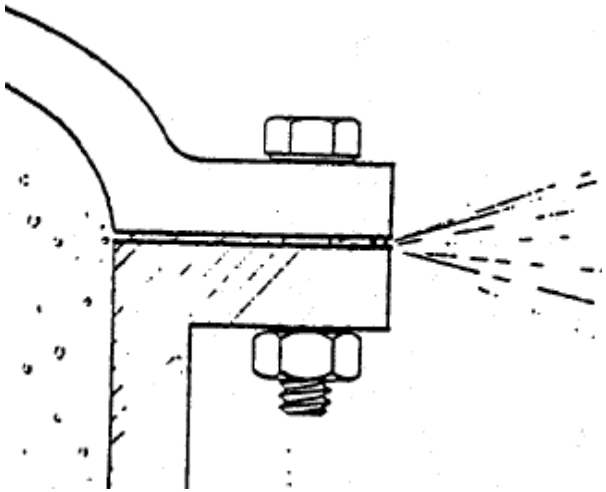


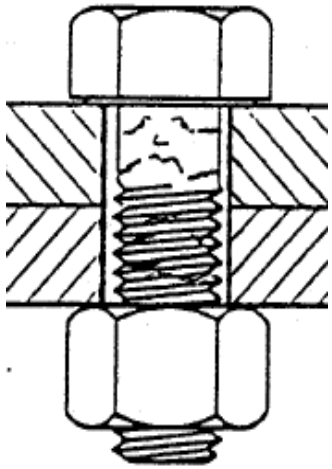
Shear Stress

What is a preloaded screw joint?









EN 14399 Structural Bolting

- EN 14399-4 HV Structural bolting for pre-loaded assemblies
  - Short thread length
  - Larger key size
  - Nut is 0,8xd
  - 10.9 quality only
  - Pre-lubricated nuts
  - Bolts, nuts and washer supplied from one supplier
  - Guaranteed clamping force at specified torque
  - Manufacturers must be approved by third part inspector – eg. TÜV
  - *k*-class K1: $0{,}10 < k < 0{,}16$
  - Supplied with 3.1 certificates on request

Stock keeping items from Dokka or Peiner!

EN 14399 Structural Bolting

- EN 14399-3 HR Structural bolting for pre-loaded assemblies
  - Thread length equal to standard bolts acc. to ISO 4014
  - Larger key size
  - Nut is 0,9xd
  - Specified in 8.8 and10.9 qualities
  - Pre-lubricated nuts
  - Bolts, nuts and washer supplied from one supplier
  - Guaranteed clamping force at specified torque
  - Manufacturers must be approved by third part inspector – eg. TÜV
  - *k*-class K1: $0{,}10 < k < 0{,}16$
  - Supplied with 3.1 certificates on request

Not available in Scandinavia…

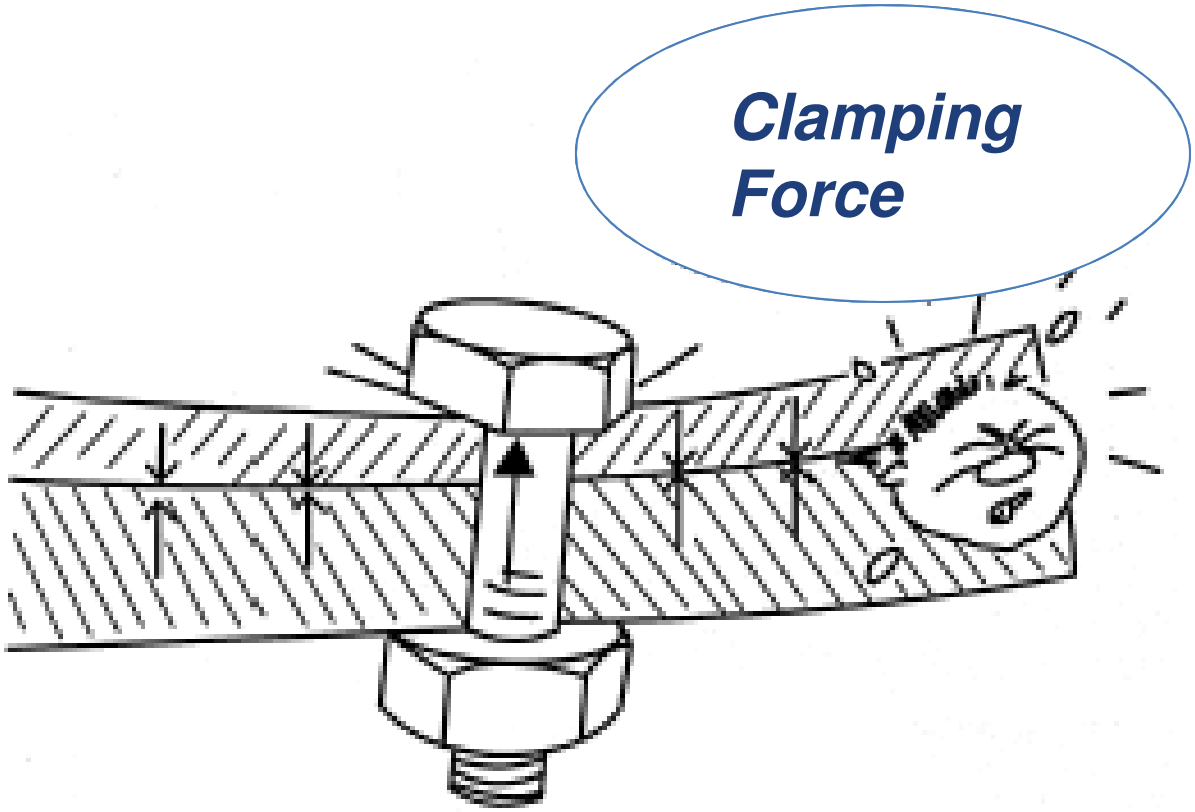
Bolting material according to EN 1090

- EN 15048 Non pre-loaded structural bolting
  - 4.8, 5.8, 6.8 or 8.8 qualities are acceptable
  - Bolts and nuts must be marked with SB
  - Manufacturers must be approved by third part inspector – e.g TÜV
  - ISO 4014/4032/7089, 4017/4032/7089
  - 3.1 certificates on request

Material on stock – but without SB-Marking

DIN 931/934/125 is no longer an option!

Installation of bolts

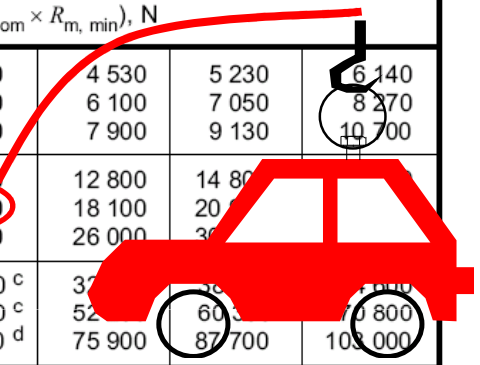


Tensile Strenght for fasteners

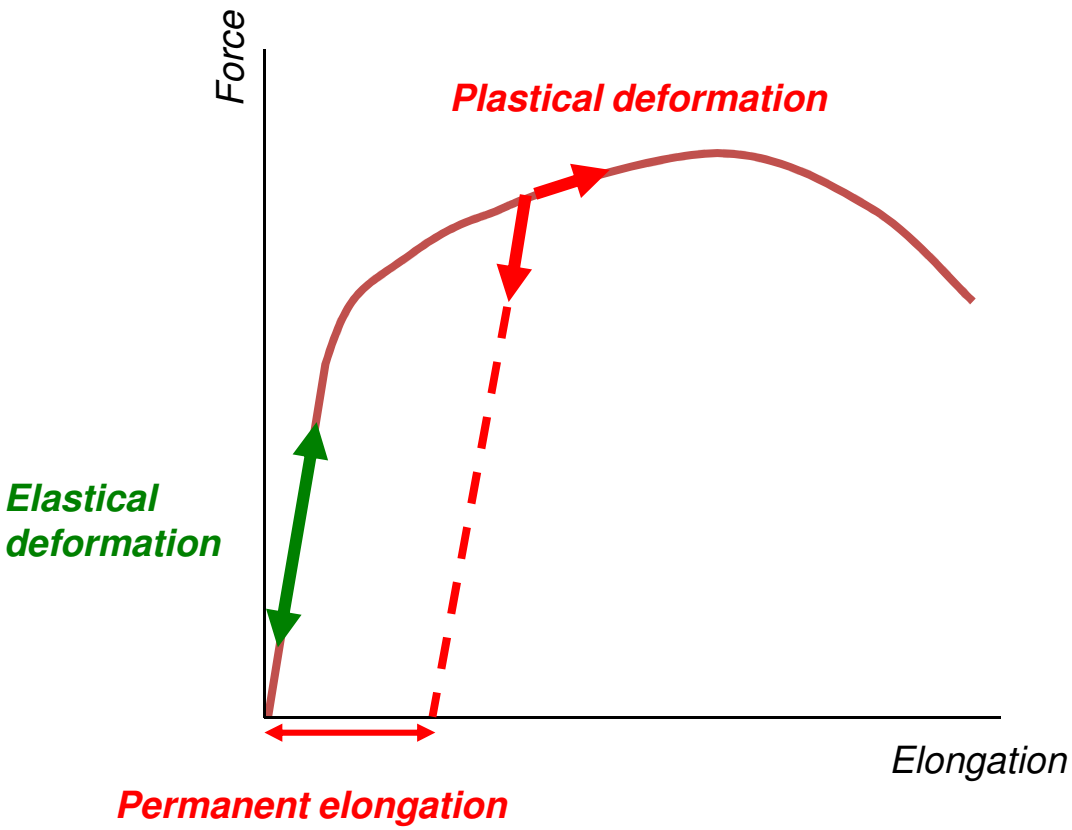
Table 4 — Minimum ultimate tensile loads — ISO metric coarse pitch thread

Thread [a] d	Nominal stress area $A_{s,nom}$ [b] mm²	Property class								
		4.6	4.8	5.6	5.8	6.8	8.8	9.8	10.9	12.9/12.9
		Minimum ultimate tensile load, $F_{m\,min}$ ($A_{s,\,nom} \times R_{m,\,min}$), N								
M3	5,03	2 010	2 110	2 510	2 620	3 020	4 020	4 530	5 230	6 140
M3,5	6,78	2 710	2 850	3 390	3 530	4 070	5 420	6 100	7 050	8 270
M4	8,78	3 510	3 690	4 390	4 570	5 270	7 020	7 900	9 130	10 700
M5	14,2	5 680	5 960	7 100	7 380	8 520	11 350	12 800	14 800	
M6	20,1	8 040	8 440	10 000	10 400	12 100	16 100	18 100	20	
M7	28,9	11 600	12 100	14 400	15 000	17 300	23 100	26 000	30	
M8	36,6	14 600 [c]	15 400	18 300 [c]	19 000	22 000	29 200 [c]	32	38	43 800
M10	58	23 200 [c]	24 400	29 000 [c]	30 200	34 800	46 400 [c]	52	60	70 800
M12	84,3	33 700	35 400	42 200	43 800	50 600	67 400 [d]	75 900	87 700	105 000
M14	115	46 000	48 300	57 500	59 800	69 000	92 000 [d]	104 000	120 000	140 000
M16	157	62 800	65 900	78 500	81 600	94 000	125 000 [d]	141 000	163 000	192 000
M18	192	76 800	80 600	96 000	99 800	115 000	159 000	—	200 000	234 000
M20	245	98 000	103 000	122 000	127 000	147 000	203 000	—	255 000	299 000
M22	303	121 000	127 000	152 000	158 000	182 000	252 000	—	315 000	370 000
M24	353	141 000	148 000	176 000	184 000	212 000	293 000	—	367 000	431 000
M27	459	184 000	193 000	230 000	239 000	275 000	381 000	—	477 000	560 000
M30	561	224 000	236 000	280 000	292 000	337 000	466 000	—	583 000	684 000
M33	694	278 000	292 000	347 000	361 000	416 000	576 000	—	722 000	847 000
M36	817	327 000	343 000	408 000	425 000	490 000	678 000	—	850 000	997 000
M39	976	390 000	410 000	488 000	508 000	586 000	810 000	—	1 020 000	1 200 000

[a] Where no thread pitch is indicated in a thread designation, coarse pitch is specified.
[b] To calculate $A_{s,nom}$, see 9.1.6.1.
[c] For fasteners with thread tolerance 6az according to ISO 965-4 subject to hot dip galvanizing, reduced values in accordance with ISO 10684:2004, Annex A, apply.
[d] For structural bolting 70 000 N (for M12), 95 500 N (for M14) and 130 000 N (for M16).



Mechanical Properties



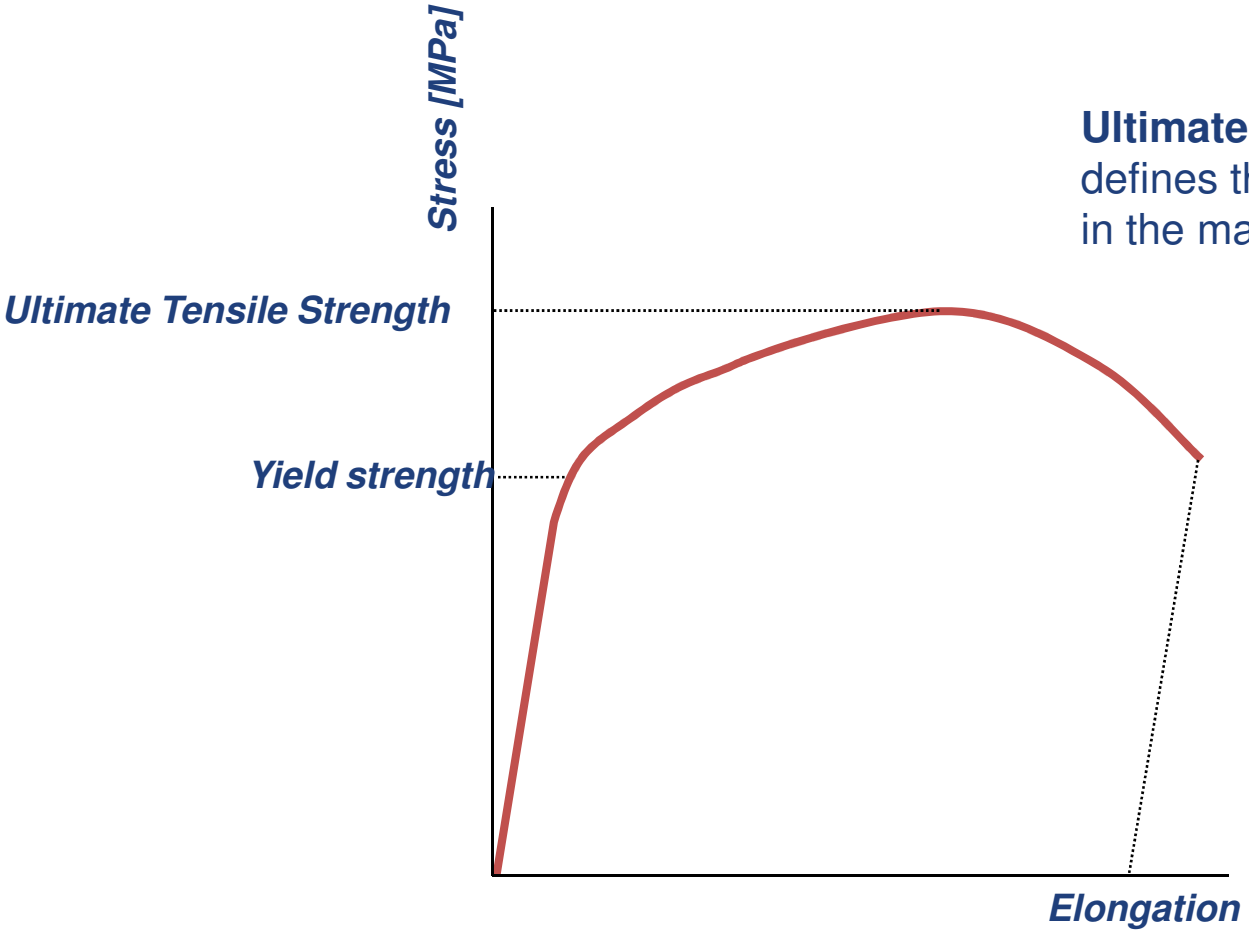
Elastic deformation

The material works as a spring and will return to the original position after load removal

Plastical deformation

The deformation remains after the load is removed

Mechanical Properties



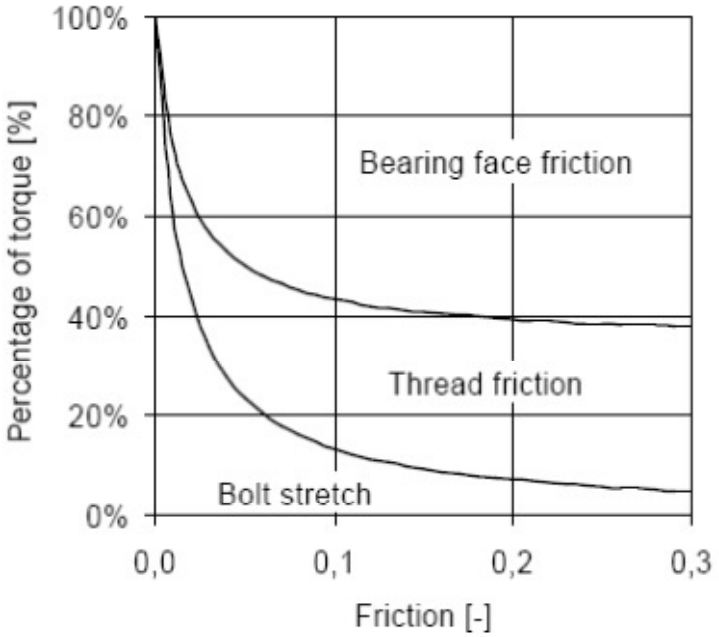
Ultimate Tensile Strenght
defines the maximum stress level in the material

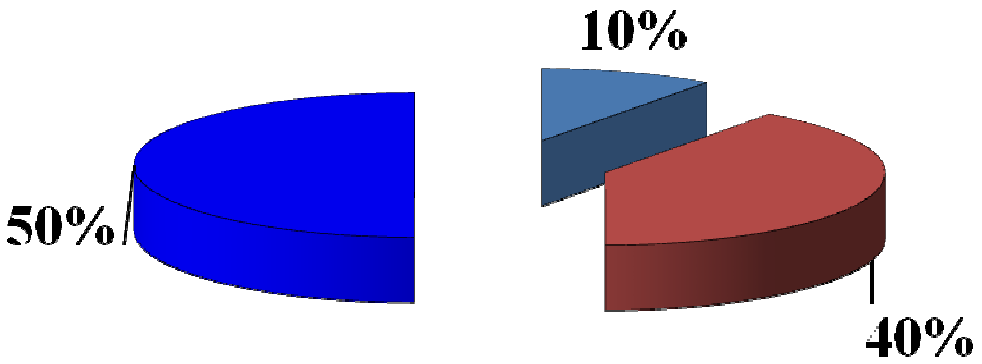
Yield Strength is defined as the transition between elastic and plastic deformation

Elongation is defined as the elongation when the material breaks in two parts $\Delta L/L_0$ [%]

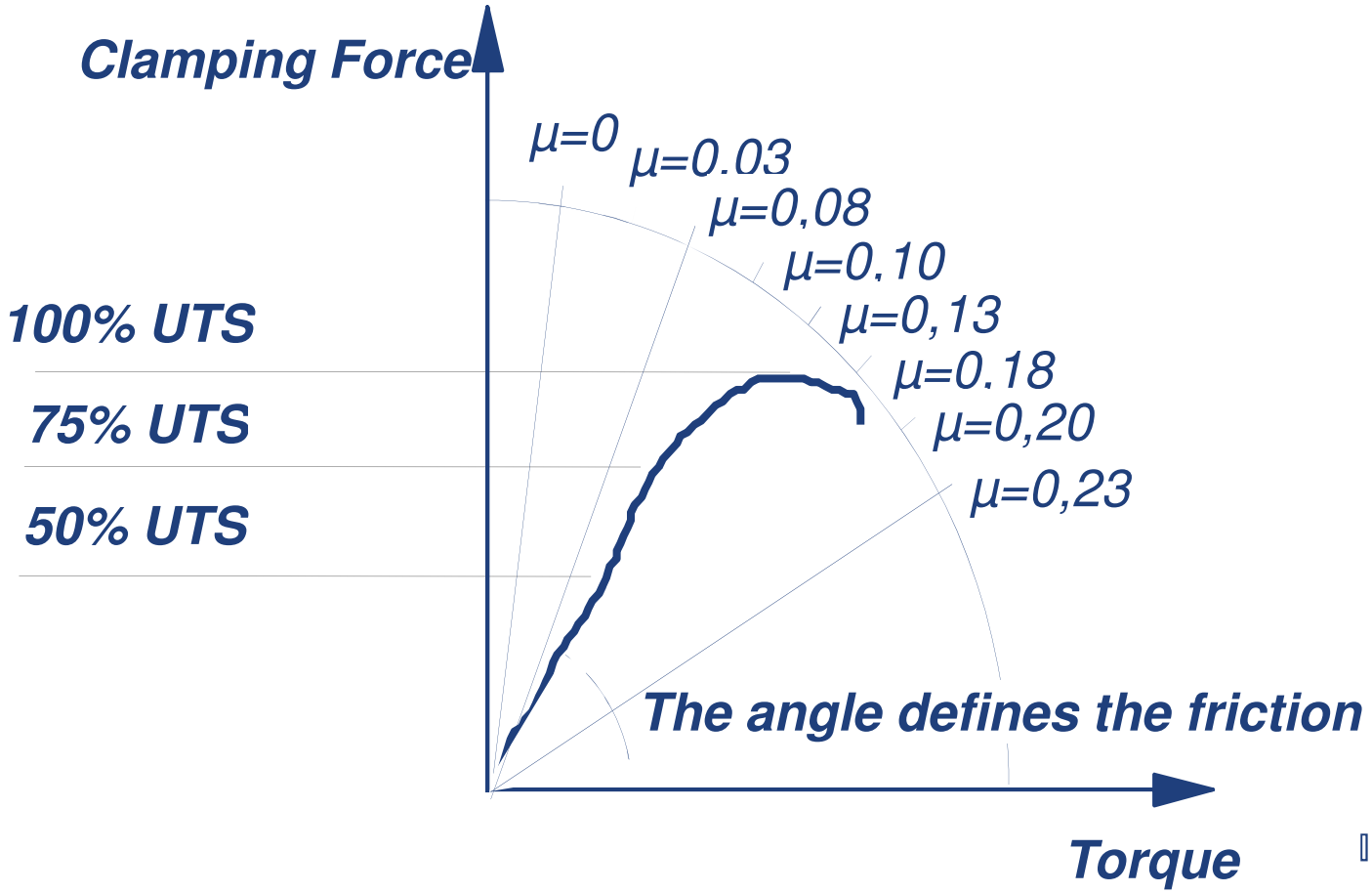
Distribution of applied torque

$$M_A = F_V \cdot \left(\frac{P}{2\pi} + \frac{\mu_G \cdot d_2}{\sqrt{3}} + \frac{\mu_K \cdot D_{Km}}{2} \right)$$

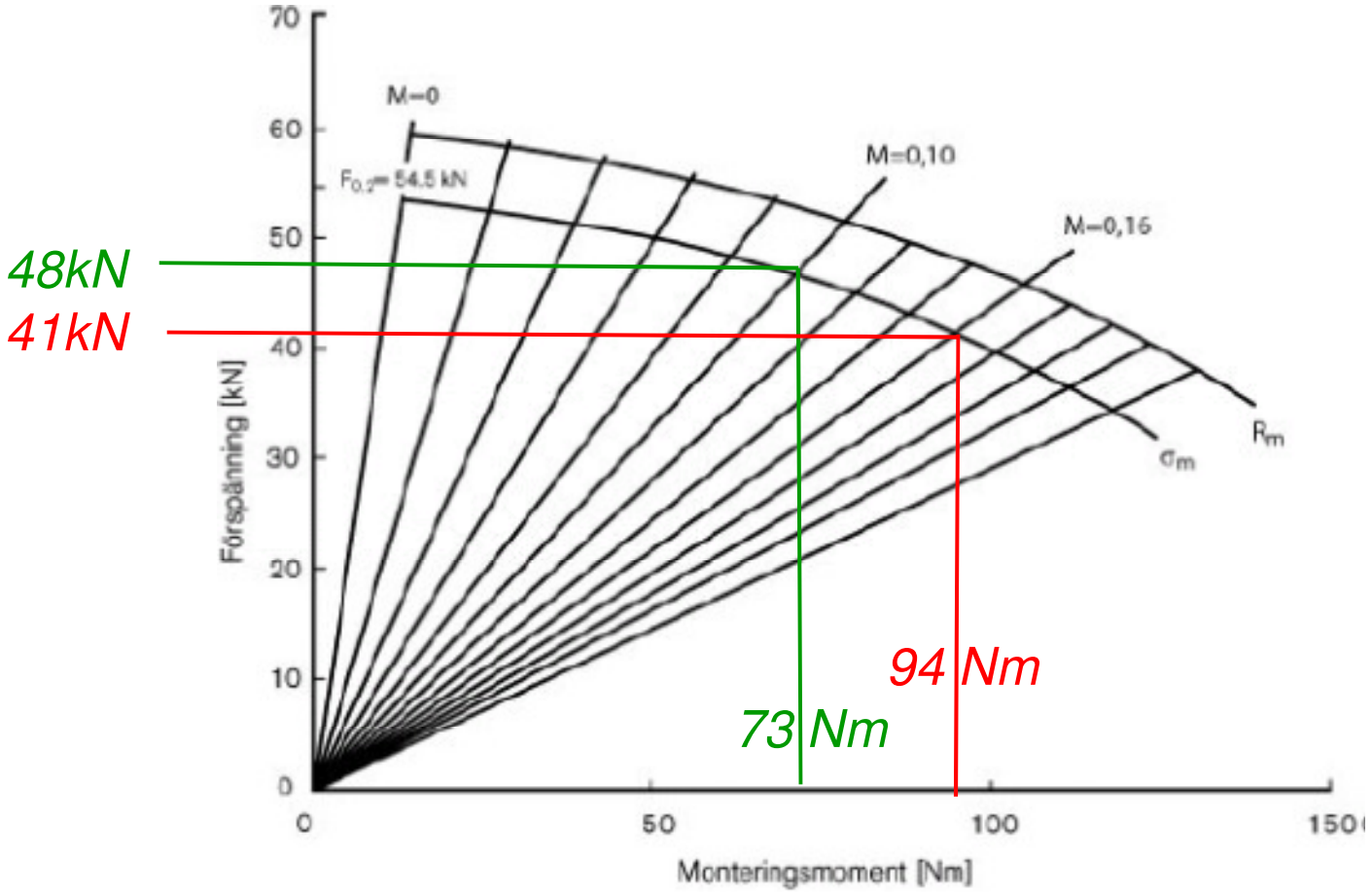




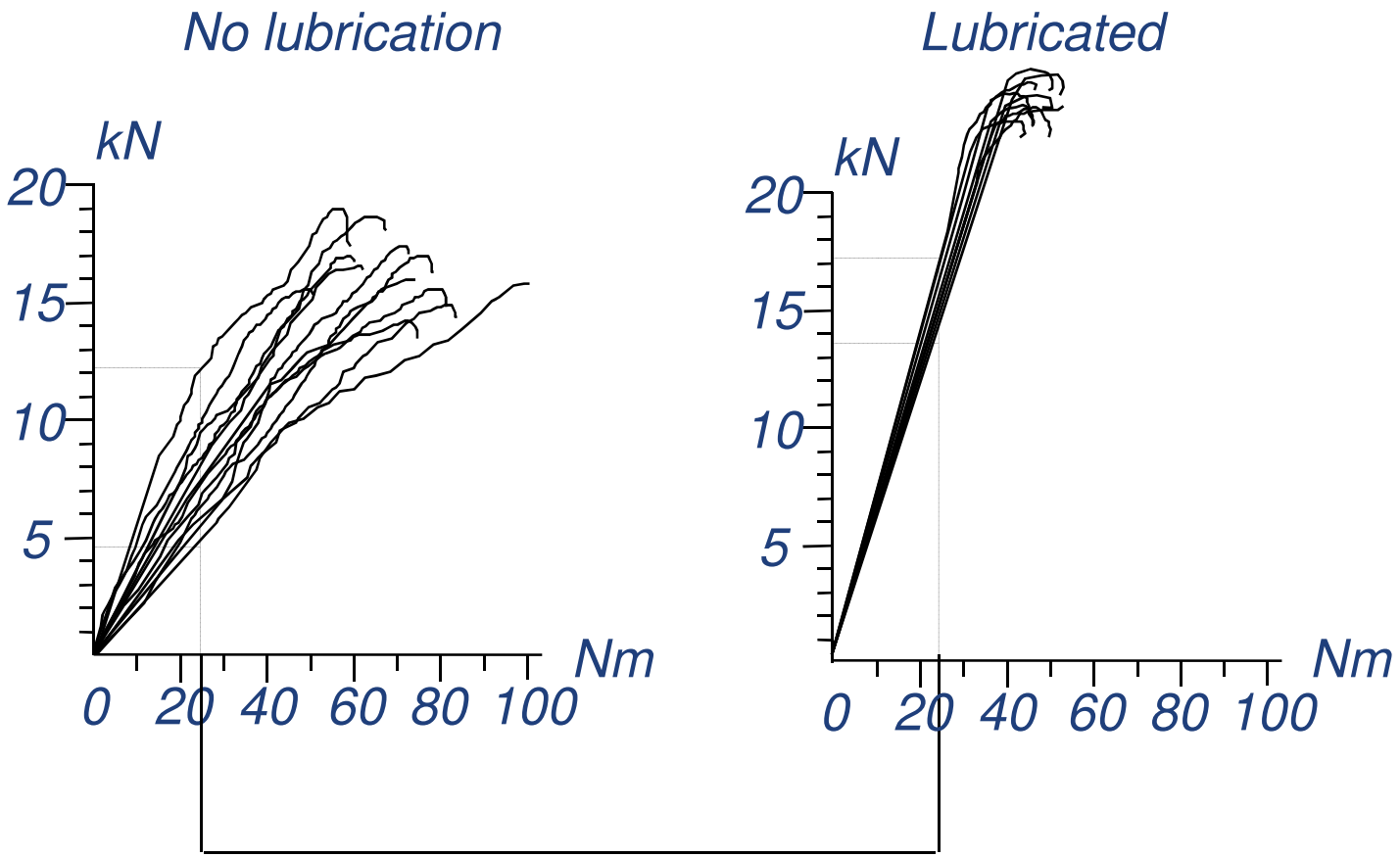
Friction


Clamping Force
μ=0
μ=0.03
μ=0,08
μ=0.10
μ=0,13
μ=0.18
μ=0,20
μ=0,23
100% UTS
75% UTS
50% UTS
The angle defines the friction
Torque

Example ISO 15071 - M10x50 - 10.9



Lubrication

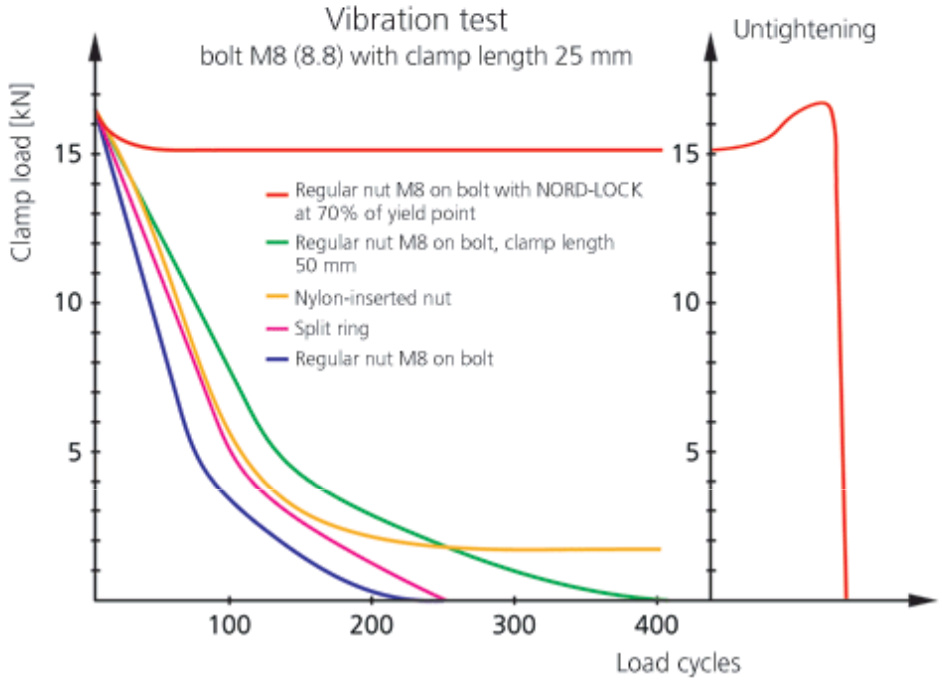


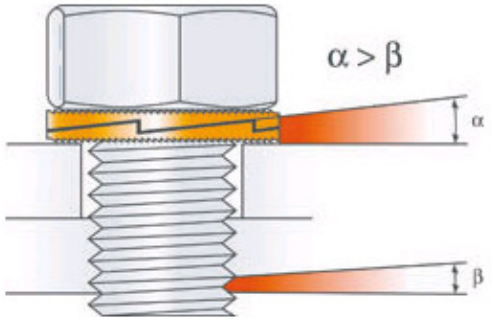
Quadrate method

$$\text{Deviation in Clamping Force} = \sqrt{\text{Deviation in Friction}^2 + \text{Deviation in Torgue}^2}$$

Deviation	Deviatoin Torque						
Friction	5,0%	10,0%	15,0%	20,0%	25,0%	30,0%	35,0%
5%	7,1%	11,2%	15,8%	20,6%	25,5%	30,4%	35,4%
10%	11,2%	14,1%	18,0%	22,4%	26,9%	31,6%	36,4%
15%	15,8%	18,0%	21,2%	25,0%	29,2%	33,5%	38,1%
20%	20,6%	22,4%	25,0%	28,3%	32,0%	36,1%	40,3%
25%	25,5%	26,9%	29,2%	32,0%	35,4%	39,1%	43,0%
30%	30,4%	31,6%	33,5%	36,1%	39,1%	42,4%	46,1%
35%	35,4%	36,4%	38,1%	40,3%	43,0%	46,1%	49,5%

Bolt locking – Locking Washers

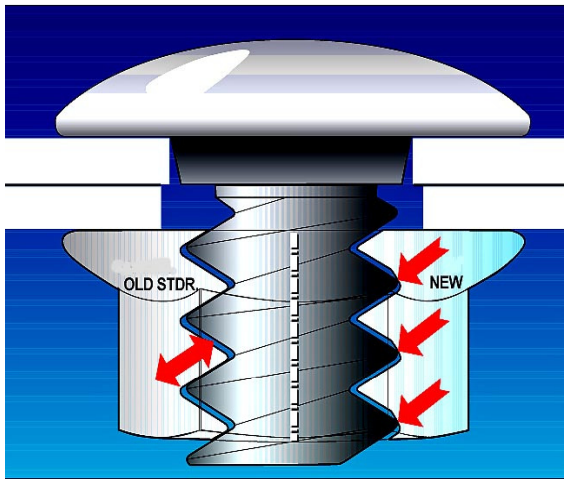




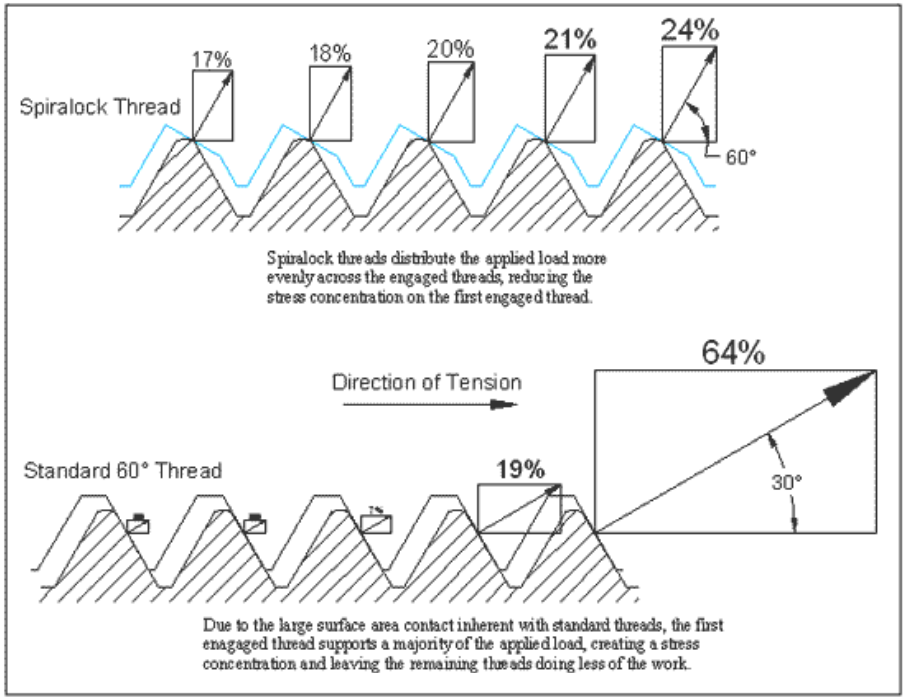
Safety washers are based on a wedge locking to give maximal security in critical screw joints with dynamic loads and vibrations.

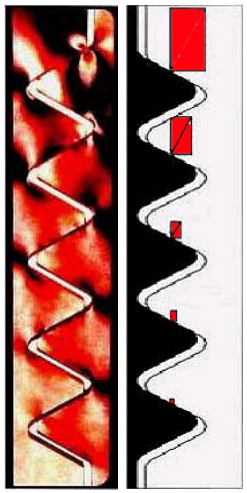
- Prevents loosening caused by vibrations and dynamic loads
- Easy to mount and demount
- Secure even at low clamping forces
- Can be reused
- Controlled friction/clamping force
- Withstands high temperatures
- The locking effect is unaffected by lubricants

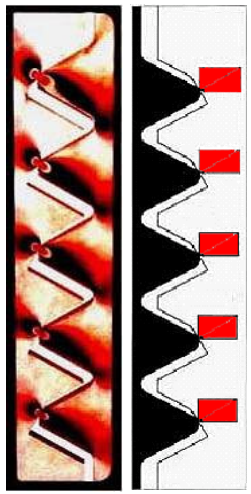
Self-Lock

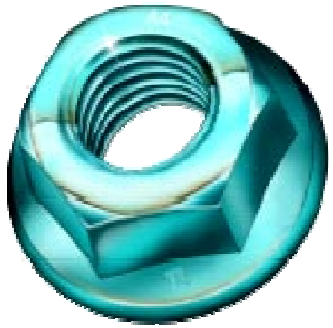


SELF-LOCK The unique profile of the thread results in a more even distribution of the force in the threaded zone. Due to several points of friction in the thread it eliminates loss of clamping force from dynamic loads and vibrations.





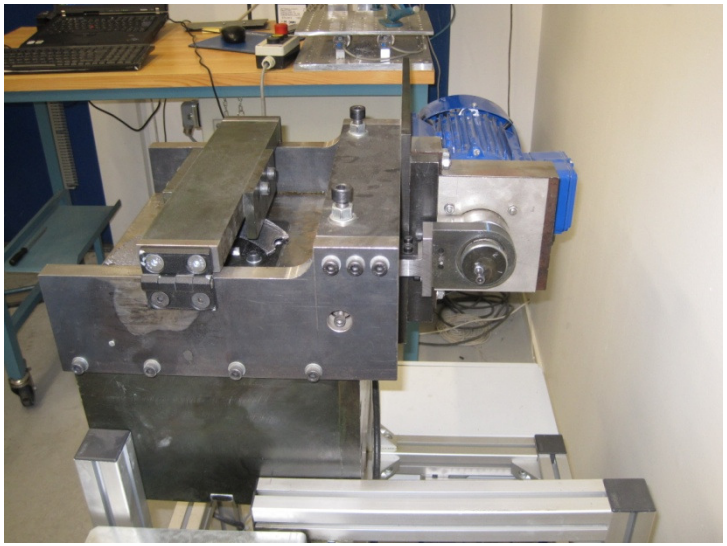


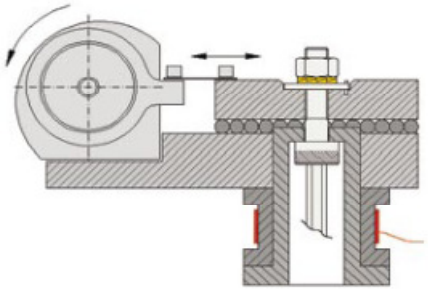


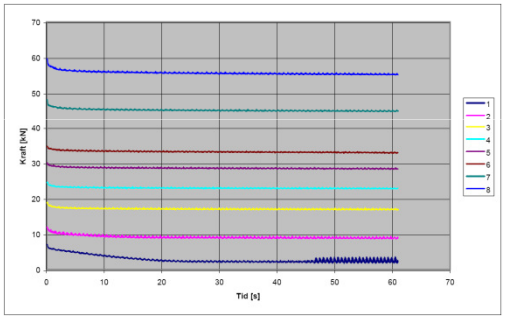
Arvid Nilsson Test Equipment

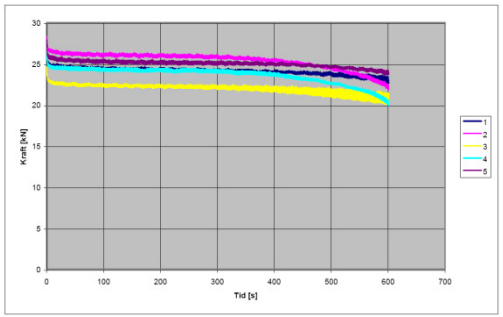
Vibration test equipment acc. to DIN 65151 Junker-method

- Test of the efficiency of locking effect in screw joints
- M6-M8-M10-M12



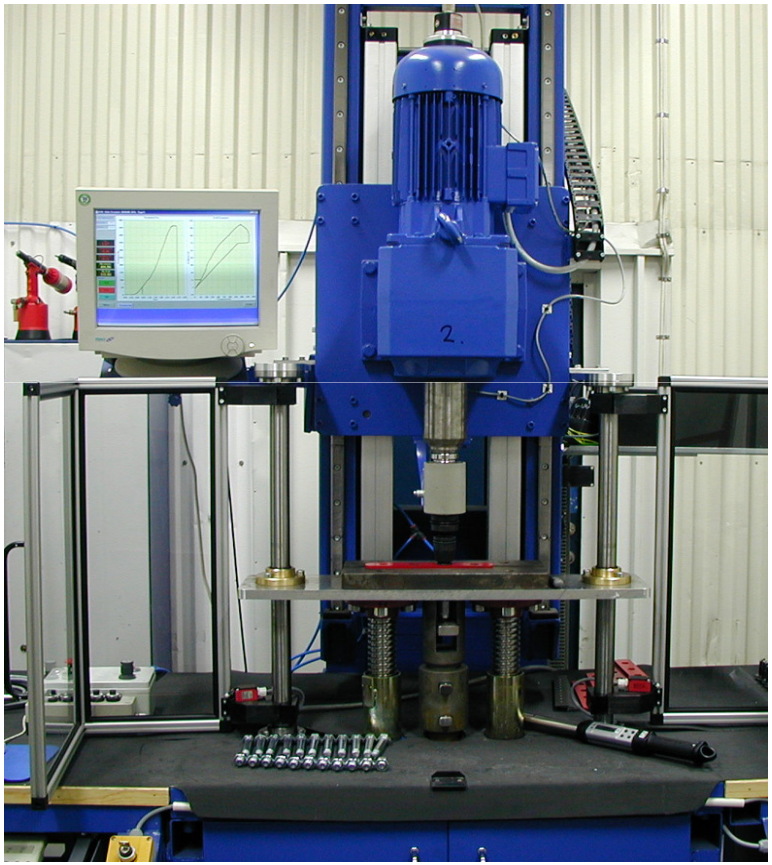






Arvid Nilsson Test Equipment

- Clamping forces:
  Up to 300 kN
- Torque: 0-1000Nm
- M6-M24 Class 8.8



- Tensile testing of full size fasteners
- Test of torque/clamping force yield
  acc.to EN-ISO 16047:2005
- Friction testing with total friction or
  separated in thread and under
  head friction

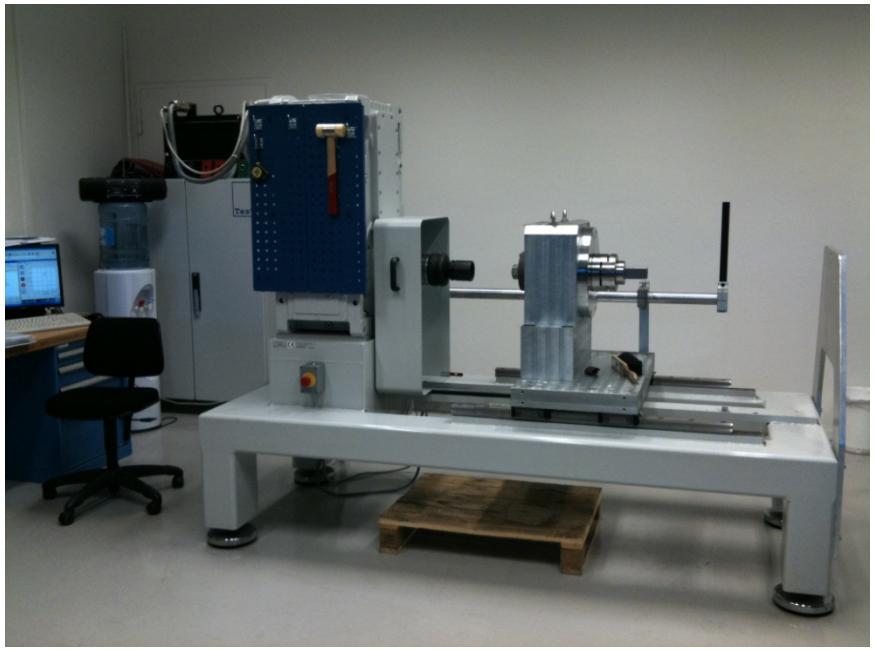
Arvid Nilsson Test Equipment

Test machine in Dokka

- Clamping force:

  Up to 3000 kN

- Torque 0-30.000 Nm
- M12-M64 Class 10.9

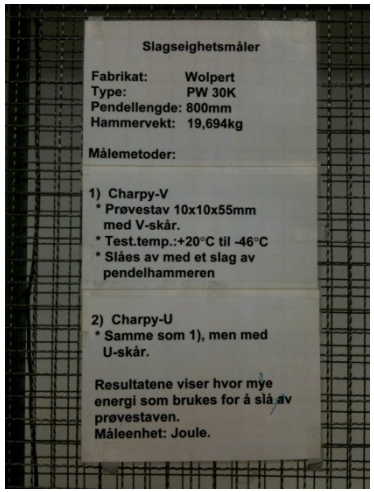


- Test to prove compliance with:

  EN 14399-2:2005

- Friction testing with total friction or separated in thread and under head friction

Test equipment



Impact testing

- Charpy V and U
- +20 to -46° Celsius

- The test piece is manufactured from a finished screw and tested with the pendulum hammer
- The result is given as the amount of energy in Joule used to break the tested material

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